we have applications to curvature, envelopes, singular points and tracing of curves.

The second part of the book contains the fundamental methods of the integral calculus, including a slight treatment of double and triple integrals and their applications to surfaces and volumes.

There is also a short chapter on differential equations, giving the methods of dealing with some of the simpler forms, and the concluding chapter contains applications to such subjects as moments of inertia and the deflection of beams.

Compared with recent English treatises on the calculus for engineering and physical students, the work before us appears slight and superficial in its technical applications. But as an elementary text-book on pure mathematics it has decided merit, and is evidently the production of an experienced teacher.

Album de Aves Amazonicas. Organisado pelo Dr. Emilio A. Goeldi, Director do Museu Paraense. (Museu Paraense de Historia Natural e Ethnographia, 1900.)

THE illustrated supplement to Dr. Goeldi's "Aves do Brazil," of which the first part, consisting of twelve coloured plates designed by Señor Ernesto Lohse, has been issued, will when completed give a good general idea of the avifauna of those regions. The birds represented in the present fasciculus comprise the cormorants, grebes, gulls, terns, waders, plovers, herons, egrets, boatbill, storks, spoonbills, rails, geese, ducks, toucans and kingfishers, as well as those two curious forms, the hoactzin and the sun-bittern. In herons and their allies the country is very rich, and two plates illustrate ten species of toucan, both sexes in this, as well as in other cases, being figured when desirable. Several species are figured on most of the plates, and they number eighty in all. But one plate is entirely devoted to a beautiful illustration (produced from an instantaneous photograph taken in 1900) of a breeding-place of the scarlet ibis. The crowd of graceful scarlet birds, backed by the rich, deep greenery of the western tropics, must afford a sight worth going to South America to see. There are pleasing bits of tropical scenery in the background of the plates, which form quite pretty pictures. The work has been printed at Zürich, and although the designs are on a rather small scale, and too much must not be expected of colour-printing, the illustrations of the birds strike us as being decidedly good, and we readily recognise at a glance several old South American acquaintances. The supplement will be most useful to any one travelling in the country who takes even a passing interest in natural history. The plates, like Dr. Goeldi's recently completed "Aves do Brazil," may be regarded as decidedly popular, and on that account will doubtless prove the more generally useful.

Qualitative Chemical Analysis, Organic and Inorganic. By F. Mollwo Perkin, Ph.D. Pp. viii + 266. (London: Longmans, Green and Co., 1901.)

THIS book begins with a general account of dry reactions and reactions in solution, attention being paid both to the manipulative and the theoretical aspects. Then follows the usual account of metals in groups with their tests, and afterwards come the acids. The remaining third of the book is devoted to what is called organic analysis, and here appears the most distinctive feature, namely, a list of tests for a great variety of organic substances—acids, alcohols, sugars, nitrogenous bases, glucosides and alkaloids. The intention of the author, as declared in the preface, has been "to write a book in which theory and practice are more or less dovetailed." It is difficult to find any realisation of this in the large section devoted to organic substances, but the treatment of the inorganic section is more in accordance with the stated object.

A. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Fire Walk Ceremony in Tahiti.

THE very remarkable description of the "Fire Walk" collected by Mr. Andrew Lang and others had aroused a curiosity in me to witness the original ceremony, which I have lately been able to gratify in a visit to Tahiti.

Among these notable accounts is one by Colonel Gudgeon, British Resident at Raratonga, describing the experiment by a man from Raiatea, and also a like account of the Fiji fire ceremony from Dr. T. M. Hocken, whose article is also quoted in Mr. Lang's paper on the "Fire Walk," in the *Proceedings* of the Society for Psychical Research, February, 1900. This extraordinary rite is also described by Mr. Fraser in the "Golden Bough," and by others.

I had heard that it was performed in Tahiti in 1897, and several persons there assured me of their having seen it, and one of them of his having walked through the fire himself under the guidance of the priest, Papa-Ita, who is said to be one of the last remnants of a certain order of the priesthood of Raiatea, and who had also performed the rite at the island of Hawaii some time in the present year, of which circumstantial newspaper accounts were given, agreeing in all essential particulars with those in the accounts already cited. According to these, a pit was dug in which large stones were heated *red hot* by a fire which had been burning many hours. The upper stones were pushed away just before the ceremony, so as to leave the lower stones to tread upon, and over these, "glowing red hot" (according to the newspaper accounts), Papa-Ita had walked with naked feet, exciting such enthusiasm that he was treated with great consideration by the whites, and by the natives as a God. I found it commonly believed in Tahiti that anyone who chose to walk after him, European or native, could do so in safety, secure in the magic which he exercises, if his instructions were exactly followed. Here in Tahiti, where he had "walked" four years before, it was generally believed among the natives, and even among the Europeans present who had seen the ceremony, that if anyone turned around to look back he immediately was burned, and I was told that all those who followed him through the fire were expected not to turn until they had reached the other side in safety, when he again entered the fire and led them back by the path by which he had come. I was further told by several who had tried it that the heat was not felt upon the feet, and that when shoes were worn the soles were not burned (for those who followed the priest's directions), but it was added by all that much heat was felt about the head.

Such absolutely extraordinary accounts of the performance had been given to me by respectable eyewitnesses and sharers in the trial, confirming those given in Hawaii, and, in the main, the cases cited by Mr. Lang, that I could not doubt that if all these were verified by my own observation, it would mean nothing less to me than a departure from the customary order of Nature, and something very well worth seeing indeed.

I was glad, therefore, to meet personally the priest, Papa-Ita. He is the finest looking native that I have seen; tall, dignified in bearing, with unusually intelligent features. I learned from him that he would perform the ceremony on Wednesday, July 17, the day before the sailing of our ship. I was ready to provide the cost of the fire, if he could not obtain it otherwise, but this proved to be unnecessary.

Papa-Ita himself spoke no English, and I conversed with him briefly through an interpreter. He said that he walked over the hot stones without danger by virtue of spells which he was able to utter and by the aid of a goddess (or devil as my interpreter had it), who was formerly a native of the islands. The spells, he said, were something which he could teach another. I was told by others that there was a still older priest in the Island of Raiatea, whose disciple he was, although he had pupils of his own, and that he could "send his spirit" to Raiatea to secure the permission of his senior priest if necessary.

In answer to my inquiry as to what preparations he was going to make for the rite in the two or three days before it, he said he was going to pass them in prayer.

The place selected for the ceremony fortunately was not far from the ship. I went there at noon and found that a large shallow pit or trench had been dug, about nine feet by twenty-one feet and about two feet deep. Lying near by was a pile containing some cords of rough wood and a pile of rounded water-worn stones, weighing, I should think, from forty to eighty pounds apiece. They were, perhaps, 200 in number, and all of porous basalt, a feature the importance of which will be seen later. The wood was placed in the trench, the fire was lighted and the stones heaped on it, as I was told, directly after I left, or at about twelve o'clock.

At 4.0 p.m. I went over again and found the preparations very nearly complete. The fire had been burning for nearly four hours. The outer stones touched the ground only at the edges of the pile, where they did not burn my hand, but as they approached the centre the stones were heaped up into a mound three or four layers deep, at which point the lowest layers seen between the upper ones were visibly red-hot. That these latter were nevertheless sending out considerable heat there could be no question, though the topmost stones were certainly not red-hot, while those at the bottom were visibly so and were occasionally splitting with loud reports, while the flames from the burned wood near the centre of the pile passed up in visible lambent tongues, both circumstances contributing to the effect upon the excited bystanders.

The upper stones, I repeat, even where the topmost were presently removed, did not show any glow to the eye, but were unquestionably very hot and certainly looked unsafe for naked feet. Native feet, however, are not like European ones, and Mr. Richardson, the chief engineer of the ship, mentioned that he had himself seen elsewhere natives standing unconcerned with naked feet on the cover of pipes conveying steam at about 300° F. where no European foot could even lightly rest for a minute. The stones then were hot. The crucial question was, *how* hot was the upper part of this upper layer on which the feet were to rest an instant in passing? I could think of no ready thermometric method that could give an absolutely trustworthy answer, but I could possibly determine on the spot the thermal equivalent of one of the hottest stones trodden on. (It was subsequently shown that the stone might be much cooler at one part than another.) Most obviously, even this was not an easy thing to do in the circumstances, but I decided to try to get at least a trustworthy approximation. By the aid of Chief Engineer Richardson, who attended with a stoker and one of the quartermasters, kindly detailed at my request by the ship's master, Captain Lawless, I prepared for the rough but conclusive experiment presently described.

It was now nearly forty minutes after four, when six acolytes (natives), wearing crowns of flowers, wreathed with garlands and bearing poles nearly fifteen feet long, ostensibly to be used as levers in toppling over the upper stones, appeared. They were supposed to need such long poles because of the distance at which they must stand on account of the heat radiated from the pile, but I had walked close beside it a moment before and satisfied myself that I could have manipulated the stones with a lever of one-third the length, with some discomfort, but with entire safety. Some of the uppermost stones only were turned over, leaving a superior layer, the long poles being needlessly thrust down between the stones to the bottom, where two of them caught fire at their extremities, adding very much to the impression that the exposed layer of stones was red hot, when in fact they were not, at least to the eye. These long poles and the way they were handled were, then, a part of the ingenious "staging" of the whole spectacle.

Now the most impressive part of the ceremony began. Papa-Ita, tall, dignified, flower-crowned and dressed with garlands of flowers, appeared with naked feet and with a large bush of "Ti" leaves in his hands, and, after going partly around the fire each way uttering what seemed to be commands to it, went back and beating the stones nearest him three times with the "Ti" leaves, advanced steadily, but with obviously hurried step, directly over the central ridge of the pile. Two disciples, similarly dressed, followed him, but they had not the courage to do so directly along the heated centre. They followed about half-way between the centre and the edge, where the stones were manifestly cooler, since I had satisfied myself that they could be touched lightly with the hand. Papa-Ita then turned and led the way back, this time with deliberate confidence, followed on his return by several new disciples, most of them not keeping exactly in the steps of the leader, but obviously seeking cooler places. A third and fourth time Papa-Ita crossed with a larger following, after which many Europeans present walked over the stones without reference to the priest's instructions. The natives were mostly in their bare feet. One wore stockings. No European attempted to walk in bare feet except in one case, that of a boy, who, I was told, found the stones too hot and immediately stepped back.

The *mise en scène* was certainly noteworthy. The site, near the great ocean breaking on the barrier reefs, the excited crowd, talking about the "red-hot" stones, the actual sight of the hierophant and his acolytes making the passage along the ridge where the occasional tongues of flame were seen at the centre, with all the attendant circumstances, made up a scene in no way lacking in interest. Still, the essential question as to the actual heat of these stones had not yet been answered, and after the fourth passage I secured Papa-Ita's permission to remove, from the middle of the pile, one stone which from its size and position every foot had rested upon in crossing, and which was undoubtedly at least as hot as any one of those trodden on. It was pulled out by my assistants with difficulty, as it proved to be larger than I had expected, it being of ovoid shape with the lower end in the hottest part of the fire. I had brought over the largest wooden bucket which the ship had, and which was half-filled with water, expecting that this would cover the stone, but it proved to be hardly enough. The stone caused the water to rise nearly to the top of the bucket, and it was thrown into such violent ebullition that a great deal of it boiled over and escaped weighing. The stone was an exceedingly bad conductor of heat, for it continued to boil the water for about twelve minutes, when, the ebullition being nearly over, it was removed to the ship and the amount of evaporated water measured.

Meanwhile others, as I have said, began to walk over the stones without any reference to the ceremony prescribed by Papa-Ita, and three or four persons, whom I personally knew on board the ship, did so in shoes, the soles of which were not burned at all. One of the gentlemen, however, who crossed over with unburned shoes, showed me that the ends of his trousers had been burnt by the flames which leaped up between the stones, and which at all times added so much to the impressiveness of the spectacle, and there was no doubt that any one who stumbled or got a foot caught between the hot stones might have been badly burned. United States Deputy-Consul Ducorran, who was present, remarked to me that he knew that Papa-Ita had failed on a neighbouring island, with stones of a marble-like quality, and he offered to test the heat of these basaltic ones by seeing how long he could remain on the hottest part of the pile, and he stood there, in my sight, from eight to ten seconds before he felt the heat through the thin soles of his shoes beginning to be unpleasantly warm.

A gentleman present asked Papa-Ita why he did not give an exhibit that would be convincing by placing his foot, even for a few seconds, between two of the red-hot stones which could be seen glowing at the bottom of the pile, to which Papa-Ita replied with dignity, "My fathers did not tell me to do it that way." I asked him if he would hold one of the smaller, upper hot stones in his hand. He promised to do so, but he did *not* do it.

The outer barriers were now removed and a crowd of natives pressed in. I, who was taking these notes on the spot, left, after assuring myself that the stones around the edge of the pit were comparatively cold, although the centre was no doubt very hot, and those below red hot. The real question is, I repeat, how hot were those trodden on? and the answer to this I was to try to obtain after measuring the amount of water boiled away.

On returning to the ship this was estimated from the water which was left in the bucket (after allowing for that spilled over) at about ten pounds. The stone, which it will be remembered was one of the hottest, if not the hottest, in the pile, was found to weigh sixty-five pounds, and to have evaporated this quantity of water. It was, as I have said, a volcanic stone, and on minuter examination proved to be a vesicular basalt, the most distinctive feature of which was its porosity and non-conductibility, for it was subsequently found that it could have been heated red hot at one end, while remaining comparatively cool at the top. I brought a piece of it to Washington with me and there determined its specific gravity to be 0·39, its specific heat 0·19 and its conductivity to be so extremely small that one end of a small fragment could be held in the hand while the other was heated indefinitely in the flame of a blow-pipe, almost like a stick of sealing-wax. This partly defeated the aim of the experiment (to find the temperature of the upper part of the stone), since only the mean temperature was found. This *mean* temperature of the hottest stone of the upper layer, as deduced from the above data, was about 1200 degrees Fahrenheit, but the temperature of the surface must have been indefinitely lower. The temperature at which such a stone begins to show a dull red in daylight is, so far as I am aware, not exactly determined, but is approximately 1300 to 1400 degrees Fahrenheit.

To conclude, I could entertain no doubt that I had witnessed substantially the scenes described by the gentlemen cited, and I have reason to believe that I saw a very favourable specimen of a "Fire Walk."

It was a sight well worth seeing. It was a most clever and interesting piece of savage magic, but from the evidence I have just given I am obliged to say (almost regretfully) that it was not a miracle. S. P. LANGLEY.

Smithsonian Institution, Washington, D.C., August 7.

The Size of the Ice-grain in Glaciers.

IN referring to the size of the grain of the glacier in the chapter on chemistry and physics in the "Antarctic Manual," I have given 700 grammes as the maximum weight which I have observed. In August, 1895, I made an extended study of the structure of glacier ice, principally from the Aletsch Glacier. The fragments of this glacier, which float as icebergs in the Mergelin See, are exposed to the powerful weathering influence of the summer sun, and are comparatively easily dissected into their constituent grains. A number of blocks were so dissected in order to ascertain the weight and size of the largest grains. The following weights of single grains were determined :—700, 590, 450, 270, 255, 170, 155 and 100 grammes. It was observed that blocks of ice contained grains of all sizes, which fitted each other so exactly that, in the fresh unweathered block, the whole volume was filled with ice.

It was not then thought necessary to determine the weight of the smaller grains. On revisiting the Mergelin See in the latter part of July of this year, I dissected several blocks of ice more or less completely and weighed their constituent grains. In order to effect the dissection a powerful sun is requisite, and a powerful sun means a high atmospheric temperature, under the influence of which the small grains melt and disappear very quickly. All the grains in the block are melting at the same time, but the smaller the grain the greater is the ratio of its external surface to its mass. Therefore the weights of the large grains are reduced in a less degree than those of the small ones. Hence it is impossible to furnish an exact statistical account of any block of ice, but the figures in the following tables give a very fair idea of the structural composition of the ice examined. The analyses of blocks E and F are the most complete.

The first block, A, is from the lower end of the Glacier des Bossons in the Chamonix valley, and it was examined on July 17, 1901, which was one of the hottest days of that very hot week. The other blocks are all from the Aletsch Glacier, as they are found floating in the Mergelin See, the waters of which are retained at one end by the ice of that glacier. The Aletsch Glacier is the largest in Switzerland and it contains the largest ice-grains that I have met with. Different parts of the glacier, even in the immediate vicinity of the lake, are of different grain, and the fragments are easily distinguished as they float in the water. Thus block F is a block of large grained ice, while E is of comparatively small grained ice, though it is by no means of the smallest grain.

List of blocks dissected.

Block A.—Chamonix, July 17, 1901. From the end of the Glacier des Bossons.

Blocks B, C and D were taken from the Mergelin See on July 21, 1901, and exposed to the sun on a rock for some hours. B and C were then dissected, though not completely; that is, a certain comparatively small portion of each of them remained undissected. D was dissected only in so far as to enable a prominent and very large grain (570 grm.) to be removed and weighed. The remainder was left till the next day. Owing to the high temperature of the air both by night and by day, its size was very much reduced. It is called Block *d*, and it was dissected on July 22, 1901.

Block E from the Mergelin See was collected and dissected on July 22, 1901.

Block F had suffered far-reaching sun weathering. It was not removed from the lake, but was dissected in the water on July 24, 1901.

The results are embodied in the two following tables. All the

TABLE I.

Weight, in grammes of single ice-grains.			
A	C	*d*	F
160	230	125	
110	210	70	590
90	200	65	550
85	150	60	460
80	130	30	360
80	75	25	325
75	60	25	250
75	60		240
60	50		240
40	50	400	190
40	50		180
35	25		155
30	25	E	150
30	25	120	150
30	25	115	140
25		105	130
		85	130
	1365	70	125
1045		60	120
		60	120
		50	120
		50	110
		50	110
B		45	100
315		35	100
220		35	90
150		30	90
90		30	80
75	D	30	75
60	570	30	60
50	225	30	60
50	95	25	45
40	75	25	45
25	75	25	45
20	50	20	30
1095	1090	1125	5765

TABLE II.

Number of grains weighed.	Aggregate weight of grains.	Average weight of one grain.	Number of grains weighed.	Aggregate weight of grains.	Average weight of one grain.
	A			*d*	
16	1045	65·3	7	400	57·1
10	110	11·0	10	30	3·0
4	25	6·25			
10	25	2·5	17	430	25·3
				E	
40	1205	30·1	22	1125	51·1
			10	150	15·0
	B		10	135	13·5
11	1095	99·5	10	120	12·0
10	95	9·5	10	60	6·0
23	60	2·6	10	50	5·0
44	1250	28·5	10	40	4·0
			10	20	2 0
	C		10	15	1·5
15	1365	91·0	102	1715	16·8
5	50	10·0			
10	25	2·5		F	
			34	5765	169·6
30	1440	48·0	10	190	19·0
			10	190	19·0
	D		10	140	14·0
6	1090	182·0	6	60	10·0
5	30	6·0	40	70	1·75
11	1120	102·0	110	6415	58·3